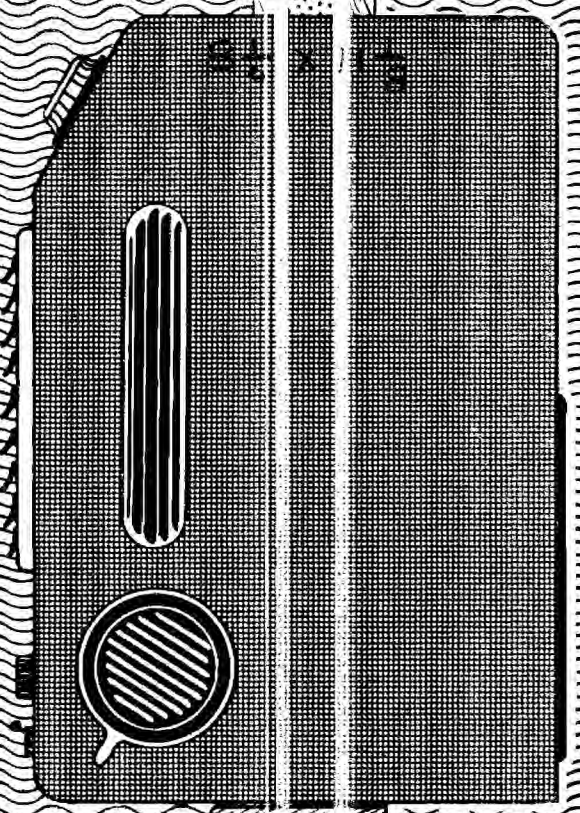

room air conditioners

A MANUFACTURING OPPORTUNITY IN GEORGIA

by Eugene Queen

Prepared for Georgia Dept. of Commerce • Scott Candler, Secretary

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY

Project B-140-9

R O O M A I R C O N D I T I O N E R S

A Manufacturing Opportunity in Georgia

Prepared for
The Georgia Department of Commerce
Scott Candler, Secretary

Eugene Queen
Research Assistant

Industrial Development Branch
Engineering Experiment Station
Georgia Institute of Technology
December, 1958

Foreword

This report offers new insights into an important manufacturing opportunity for Georgia. The factors upon which the study focuses--climate and income--have long been considered of "obvious" importance to the sale of room air conditioners. However, there have been to date but limited efforts to determine statistically what the precise effects of these key factors might be.

By providing statistical measures of the degree of influence exerted by each factor, Mr. Queen's analysis suggests a new and valuable basis for forecasting sales of room units. As the report shows, this information casts a new light on questions important to the location of new manufacturing plants.

Comments or questions regarding the analysis are invited. More detailed information regarding specific location possibilities within the area recommended for a room air conditioner manufacturing plant will be provided on request.

Kenneth C. Wagner, Head
Industrial Development Branch

Acknowledgments

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SUMMARY

This study is concerned with the spatial distribution of the market for room air conditioners, both present and future, and with the implication of the findings for plant location decisions.

Briefly stated, the findings are these:

1. There are at least two major regional markets which may be differentiated on the basis of the importance of factors which influence purchase decisions: the desire for comfort and the ability to pay for it.

2. One of these regions, corresponding roughly to the South Atlantic, East South Central, and West South Central states, has a greater potential for market growth than the other, consisting roughly of the New England, Middle Atlantic, East North Central and West North Central States. 1/

3. As a consequence, the national market center, which is now in the vicinity of Louisville, Kentucky, may be expected to shift southward, and in turn, the plant locations which would provide the maximum effectiveness in national market penetration may be expected to lie south of Louisville.

4. Specialization in a regional market could be pursued most effectively in the southern states.

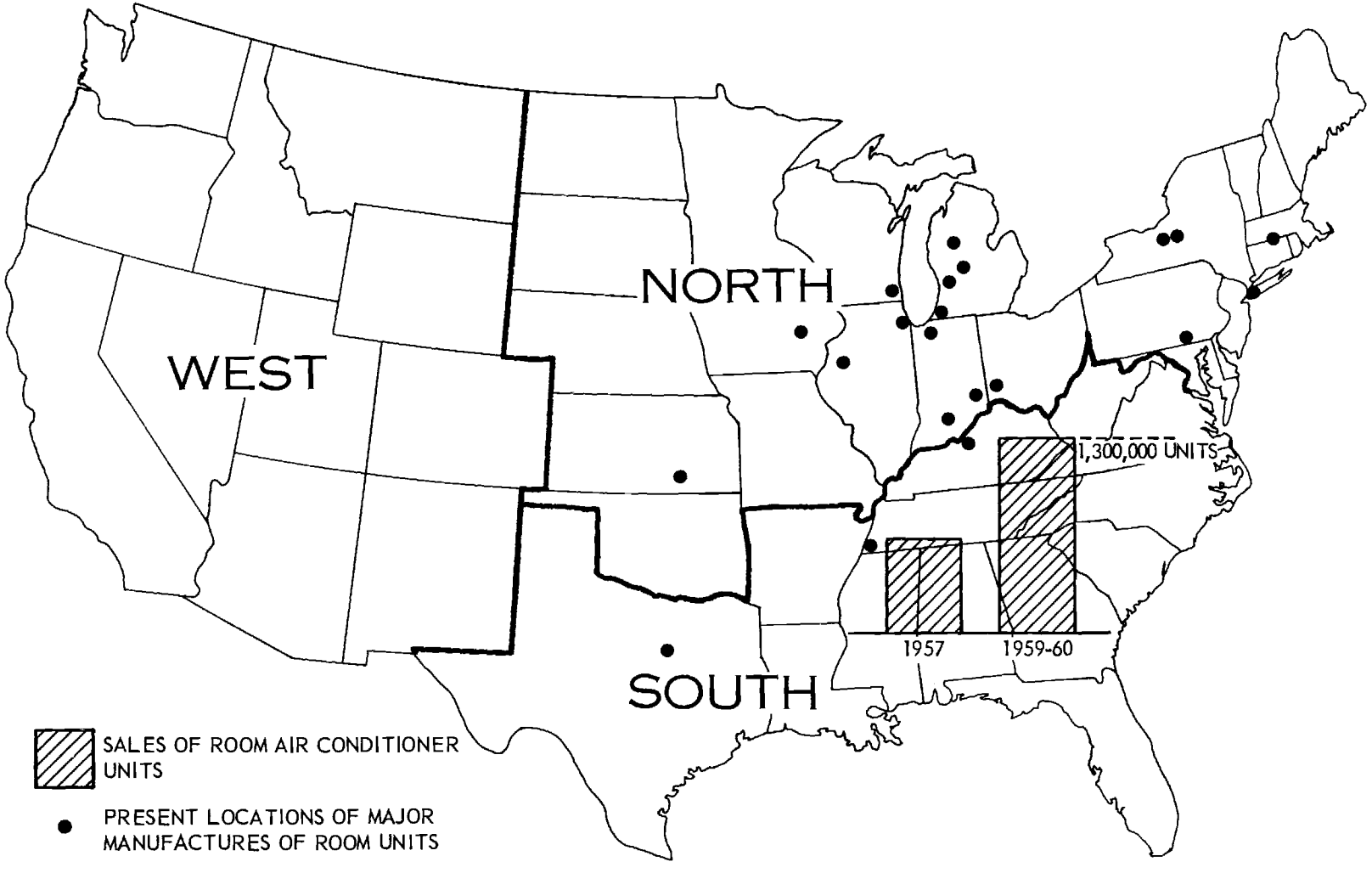
Given the unique importance of purchasing power in the southern market, as developed by the analysis, and the assumption of continued income growth in that region, it is reasoned that the market growth in the south is causing a continuing shift southward of the market center.

Predicated on the thesis that the market center is in general an optimum location for manufacturing facilities, and on the inference of a continuing southward shift from the results of the market analysis, three cities are identified as worthy of consideration in future plant location decisions.

One of these cities, Atlanta, a major distribution center for the South, offers excellent transportation facilities, established marketing channels, labor with varied degrees of skill, and other advantages which make it one of the most favored areas for plant location in the South. Further and more detailed consideration of this metropolitan area is recommended as a prerequisite to a location decision.

1/ Readers not familiar with Census definitions of regions may refer to Map 2.

MAP 1
MAJOR REGIONAL MARKETS FOR ROOM AIR CONDITIONERS



I. INTRODUCTION

Many of the conclusions drawn in this report are based on the effects of climatic and income differentials on the geographic distribution of room air conditioner sales. That such effects do exist is nothing new; certainly there is no intent here to belabor such an obvious point. Nevertheless, further understanding of the market for this product can be gained by a re-examination of these effects. Measurement of the extent of the interrelationships among sales, income, and climate, in particular, can lead to more definite and more fruitful conclusions than those intuitively accepted as "obvious."

Mere intuition is often sufficient to describe and predict the behavior of an individual; indeed, it is sometimes more appropriate than an analytical tool that presupposes rational behavior. But in dealing with mass consumer behavior with characteristics that differ among the various regions, a more objective approach is needed. Such an approach is taken here, in that the "obvious" is treated as an hypothesis.

The Second Section demonstrates that there is an empirical basis for defining regional markets for room air conditioners. Statistical treatment of sales data on a regional basis confirms the theoretical argument that income and climate are among the major determinants of sales, and measures the degree of influence exerted by these factors within the three regions defined in Section II.

A forecast of 1959-60 production of room units is made in Section III, with a very brief consideration of the southern region's probable share of that market.

In Section IV, a simple scheme is constructed for the purpose of locating the market center, based on the 1957 distribution of sales.

Section V devotes attention to the merits of the general vicinity of Atlanta as regards plant location factors. More detailed information will be provided as desired for any firm seeking a location meeting a particular set of requirements.

II. THE MARKET ANALYSIS

Sample sales data obtained from a large number of utilities, were used to estimate sales of room air conditioners by states.[1/] Map 2, which follows, shows the distribution of sales by Census regions. It is questionable, however, whether this definition of regions is appropriate for room air conditioner markets. It is apparent that there is considerable variation among the states in sales volume. A critical question, therefore is: What are the factors which determine sales volume?

The answer could encompass many particulars, but it will be simplified in the present case to consider only certain measurable factors. Certainly the desire for comfort, in so far as a room air conditioner can provide it, and the necessary purchasing power are two pertinent factors. Admittedly, the conditions necessary for human comfort are complex, but relief from high temperatures and excessive humidity are primary considerations.

Bosen and Thom of the U.S. Weather Bureau have made considerable progress in developing measures of the need for summer cooling. Thom has recently published values termed "cooling degree days" for a number of cities throughout the United States.[2/] The cooling degree days variable is used in this study as one of the factors influencing purchase decisions. Not all states could be

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1/ Appendix I sets forth in detail the methodology used for these estimates.

2/ J. F. Bosen, Office of Climatology, U.S. Weather Bureau, Washington, D. C., has developed two linear equations which provide a Discomfort Index appropriate to the need for summer cooling. The first equation involves dry bulb and wet bulb temperatures; the second, dry bulb temperature and dew point temperature.

Earl C. Thom, Meteorologist, U.S. Weather Bureau, Washington, D. C., has proposed the Discomfort Index as a basis for measuring cooling degree days. A base figure of 60 is subtracted from the average Discomfort Index for each day, and the remaining values are accumulated into monthly and annual totals of cooling degree days.

The equations are:

(1) $DI = 0.4(t_d + t_w) + 15$

(2) $DI = 0.55t_d + 0.2t_{dp} + 17.5$

DI = Discomfort Index

t_d = Dry bulb temperature

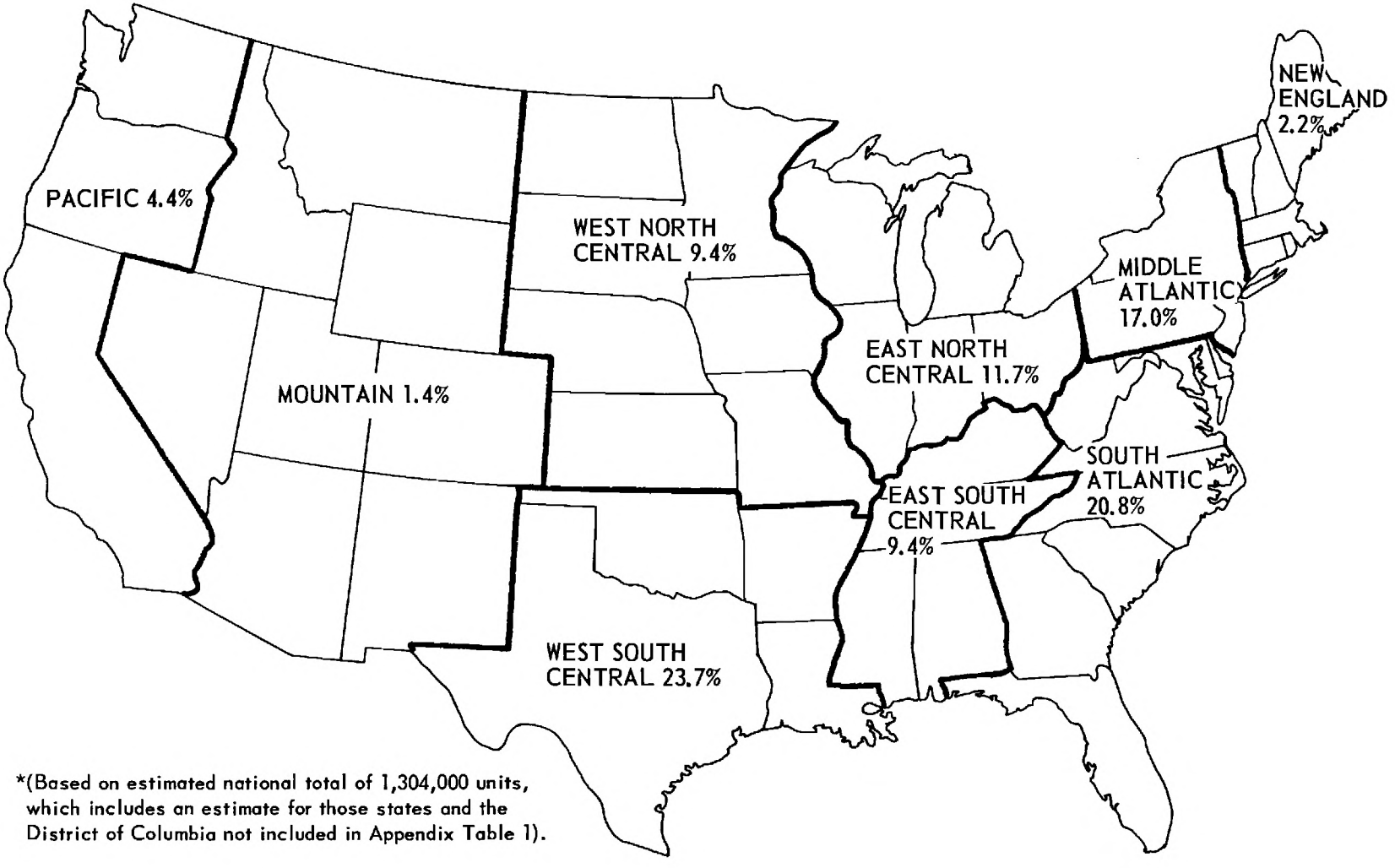
t_w = Wet bulb temperature

t_{dp} = Dew point temperature

All t values are simultaneous

For further discussion, see "Cooling Degree Days," E. C. Thom, July 1958, p. 65ff., The Industrial Press, New York.

MAP 2
ROOM AIR CONDITIONER SALES*
(Percentage Distribution By Regions)



*(Based on estimated national total of 1,304,000 units, which includes an estimate for those states and the District of Columbia not included in Appendix Table 1).

considered in the analysis, since cooling degree data for some of them were not available. Per capita income in the various states was used as a measure of purchasing power.

The analysis which follows is a study of the relationships between the two factors--"climate" and income--and sales per thousand domestic customers of the electric utilities. The method employed to measure these relationships is multiple correlation, and the hypothesis is that sales are "dependent" upon income and the climatic factor.

The basic data are given in Table I. The results of the analysis are arranged in tabular form in Table II. Contrary to expectation, it will be noted that in the aggregate, sales are negatively correlated with cooling degree days. As will be seen, the aggregative analysis is somewhat deceiving, in that the coefficients reflect implicitly the fact that most of the high income states are in the North, and the states where air conditioning is most needed or desirable are generally in the low-income group.[1/]

The aggregative analysis also suggests that a basis for developing more appropriate regional definitions is needed for the purposes of this market study. The basic concept in regional grouping is dual. First, the region must be unbroken and continuous. Second, it must be relatively uniform in climate or income. The question is whether regions can be defined in terms of geographic areas differing in income and climate characteristics.

The Regions

The various states were ranked according to per capita income and number of cooling degree days, and then compared for similarities of state groupings. There are patterns in these listings, although some slight modification is necessary to preserve geographic grouping.

Two groups of states are well defined. The first consists of Arkansas, Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Texas. The second group is composed of Illinois, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New York, North Dakota, Ohio

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1/ When this is taken into account in the second order coefficients, the negative correlation between sales and income ($r_{12.3}$) become somewhat smaller. The final result ($R_{1.23}$), which takes both factors into consideration simultaneously, reflects a considerable degree of "improvement" over the lower order coefficients, i.e., it tends to better agreement with the hypothesis. These results are not particularly enlightening, except to serve as a contrast to the results obtained when the same methods are applied to the same data grouped as various regions.

TABLE I

SALES, PER CAPITA INCOME, AND COOLING DEGREE DAYS
FOR SELECTED STATES, 1957

State	Sales (per 1000 Customers)	Per Capita Income	Annual Cooling Degree Days
Massachusetts	8	$ 2,335	1020
New York	28	2,578	1056
Ohio	16	2,255	1342
Illinois	21	2,447	1195
Michigan	4	2,141	311
Minnesota	19	1,850	954
Missouri	36	1,940	1756
North Dakota	25	1,435	745
Nebraska	31	1,818	972
North Carolina	27	1,317	2182
South Carolina	80	1,180	2549
Georgia	80	1,431	2168
Florida	42	1,836	3763
Tennessee	77	1,383	2119
Alabama	37	1,324	2755
Mississippi	21	958	2583
Arkansas	44	1,151	2302
Louisiana	102	1,566	3026
Oklahoma	36	1,619	1905
Texas	82	1,791	2812
Montana	3	1,896	606
Wyoming	12	2,038	405
Colorado	4	1,996	556
New Mexico	14	1,686	951
Arizona	24	1,750	2227
Utah	5	1,694	767
Nevada	25	2,423	990
Washington	4	2,128	247
California	13	2,523	1245

Source: Income data from Survey of Current Business, August 1958. Cooling degree data are from Thom's article in Air Conditioning, Heating, and Ventilating, July 1958, pp. 68-72.

and Oklahoma. A third group which is less well defined comprises Arizona, California, Colorado, Montana, Nevada, New Mexico, Utah, Washington and Wyoming.

A third ranking of states in order of total sales volume was used in part as confirmation of these conclusions, and to aid in assigning states for which no cooling degree data were available. Much the same pattern emerges if states are checked off on a map of the United States as they appear in this last ranking. See Map 3.

Thus, the two major regional markets seem to consist of one group of states ranging eastward from the Great Plains through the Middle Atlantic states up to New England, and a second group extending southward from the Middle Atlantic states and over the Gulf Coast into Texas.

The Analysis

As a test of these regional definitions, correlation techniques may be applied to the data for these regions, as was done for the national data. The results appear in Table II. The differences from the overall or aggregative analysis are of considerable importance.

First, the fact that differences do exist proves that the joint influence of climatic factors and income is of a different nature among the regions. This establishes the case for regional market differentiation. The general improvement of the correlation coefficients resulting from the market breakdown demonstrates the validity of the groupings, granted the *a priori* hypothesis that income and the climatic factor are major determinants of sales.

Second, the nature of the differences has specific implications for future market growth.

In the "South," income is clearly the dominant factor in determining sales. The climatic factor does not specifically enter in, except in the sense that the climate is uniformly such that a room air conditioner is desirable.

In the other major market area, climate is dominant. Income is available, provided that climatic factors make an air conditioner sufficiently desirable to warrant its purchase. Thus, occasional cool summers may depress considerably the sales of room units in this region.

In the region composed of the Mountain and Pacific states, both factors are considerations, but the climatic factor is more important.

MAP 3
RANK OF STATES IN SALES OF ROOM AIR CONDITIONERS, 1957
(Thirty States Comprising 97.3 Per Cent Of The Market)

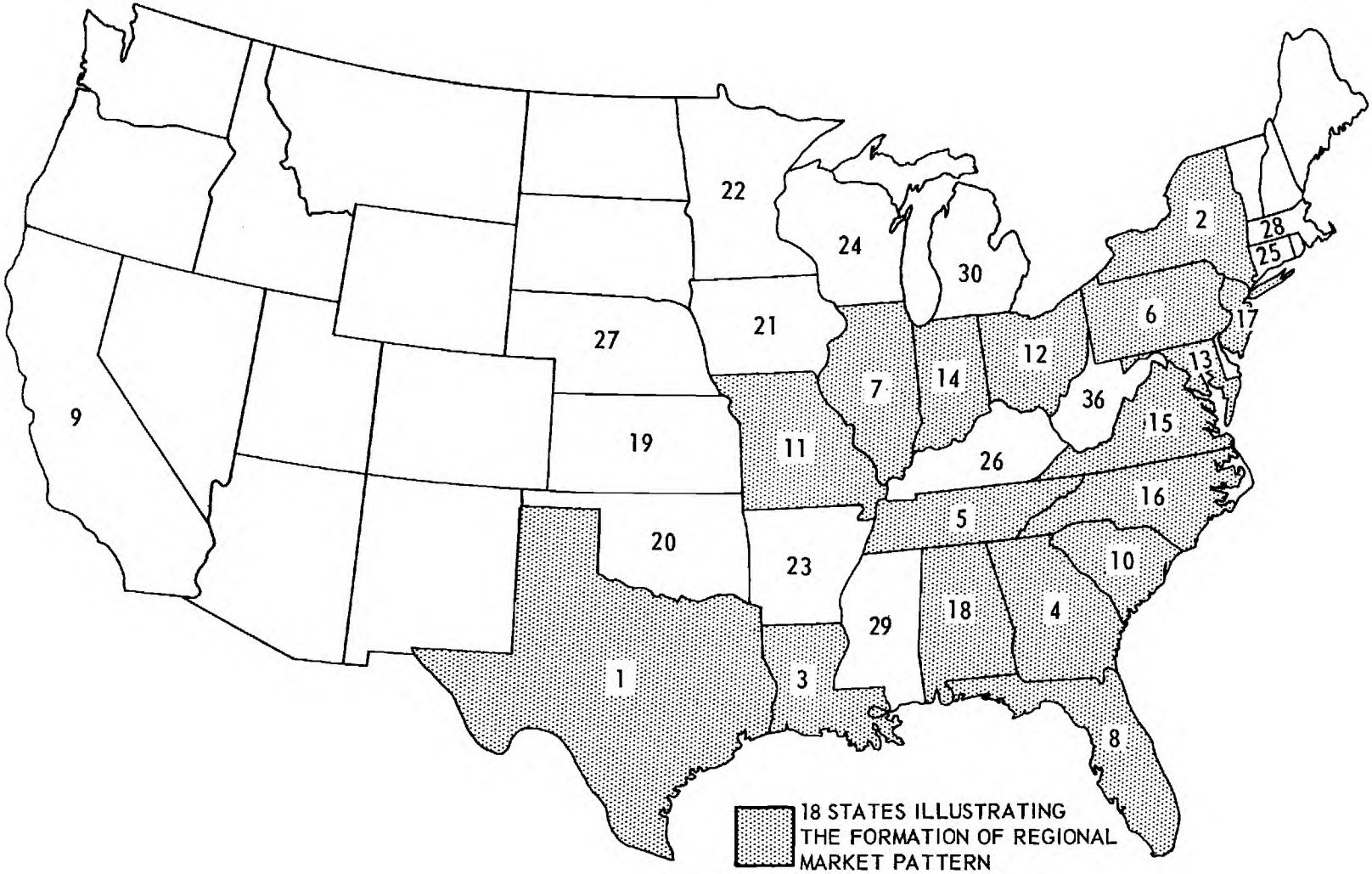


TABLE II

RESULTS OF CORRELATION ANALYSIS

Coefficient Symbols[1/]	Correlation Coefficients			
	Aggregative	"South"	"North"	"West"
r_{12}	-0.46	0.42	-0.41	0.22
r_{13}	0.73	-0.003	0.70	0.73
$r_{12.3}$	-0.12	0.54	-0.47	0.44
$r_{13.2}$	0.64	-0.37	0.72	0.77
$R_{1.23}$	0.73	0.54	0.78	0.79

1/ For the analysis, per capita sales was designated X_1, per capita income as X_2, and cooling degree days as X_3. The interpretation of r_{12} is therefore the correlation between "per capita" sales and per capita income. The notation is standard, $r_{12.3}$ being the correlation between per capita sales and per capita income, with the other factor, cooling degree days, held constant statistically. $R_{1.23}$ is the coefficient of multiple correlation, a measure of the variability in per capita sales associated with the variability in both of the other variables.

With the growth of room air conditioner sales over the past six years, shifts have occurred in the spatial distribution of the market. Indeed, much of this growth is attributable to a shift; namely, increased penetration of the southern market. From 1952 to 1957, the average retail price of room units declined. During this same period, per capita income in the Southeast, for example, increased from $1,194 to $1,427. Considering the relative importance of purchasing power in the "South," it is almost certain that the increasing income and declining price combined to increase sales to the extent that total market growth is in large measure attributable to growth in the southern regional market.

The implication is that sales in the southern region may be expected to increase over time with income growth. Sales in the other regions, however, are more subject to the vagaries of year to year weather conditions. Thus the real growth[1/] in the room air conditioner market will occur in the "South." In other words, the market center of the nation will continue to shift southwards.

1/ By real growth is meant increased sales relative to consumer population, i.e., an increased rate of buying not attributable to population growth.

III. A MARKET FORECAST

One of the basic assumptions of this study is that the market for room air conditioners will continue to grow. At the same time, substantial future growth of the national market is a major inference from the analysis, based on the increasingly important role played by southern markets, and the evidence that enlargement of these markets is closely allied to income growth. The question of how much growth may be expected in the national and regional markets is obviously pertinent to location decisions. Therefore, an attempt is made here to answer that question.

Two methods of forecasting were used, with results in close agreement. The first method is simply a statistical examination of production data, in a search for consistent patterns of growth behavior over the past 11 years (1947 to 1957). Statistically speaking, the second method is slightly more sophisticated, in that it utilizes the relationship between income and the level of production. A brief discussion of these techniques may be found in Appendix II.

A logarithmic graph of the adjusted production data (Figure 1) shows clearly a marked acceleration in growth from 1951-52 to 1953-54 (a reflection of the sharp rise in the actual data from 1952 forward), followed by a period of lesser but more steady growth (which is not evident in an arithmetic graph of the data).[1/]

Figure 2 shows no marked tendency to regularity in production growth. A more nearly linear path would provide a much better basis for forecasting, and a statistical transformation designed to reveal such hidden tendencies was applied.

The result is the interesting curve in Figure 3. An extrapolation of the nearly linear growth of the last four years, after correction for the transformation applied earlier, gives a production forecast of about 2,250,000 units for 1959-60.

1/ A transformation explained in Appendix II clearly indicates a substantial upward shift of supply and, possibly, demand. The upward shift was due to expansion of production facilities, and entrance of new producers into the market. There is a strong suggestion that the present growth rate in production (and therefore sales) is about the same as in earlier years, but at a much higher level. Compare Figures 1, 2, and 3.

As an alternative, the relationship between production and U.S. total personal income was formulated empirically, and used as a means for forecasting production based on a forecast of income. After determining the nature of these various relationships, a forecast of 2,280,000 units was obtained for 1959-60.

Each of the two methods rest upon assumptions about stability of the economic factors involved, but in view of the short range of the forecasts, they are believed to be not only reliable but probably conservative. Forecasts for the more distant future would become increasingly speculative, due to the shortness (10 years) of the series used as a basis.

The future magnitude of the southern market cannot be described with precision. At the time of this writing, historical data similar to estimates for 1957 contained in this report have not been developed, and an elaborate analysis cannot be justified.

It is appropriate to consider what the "South's" share of the national market might be by 1960. A conservative estimate would be 55 per cent, or approximately 1,245,000 units; a more optimistic estimate of 60 per cent would mean 1,359,000 units. Either of these estimates is greater than total national production in any year prior to 1954.

Market growth is to be expected in other regions, of course, but in view of the analysis, growth elsewhere will not be as great, absolutely or relatively, as in the South. The market expansion in other regions will be tied to such factors as population increase and family formation; in the South, the additional powerful influence of income growth will dominate.

FIGURE 1
U.S. ROOM AIR CONDITIONER PRODUCTION, 1947-1957
(Original Data, In Thousands Of Units)

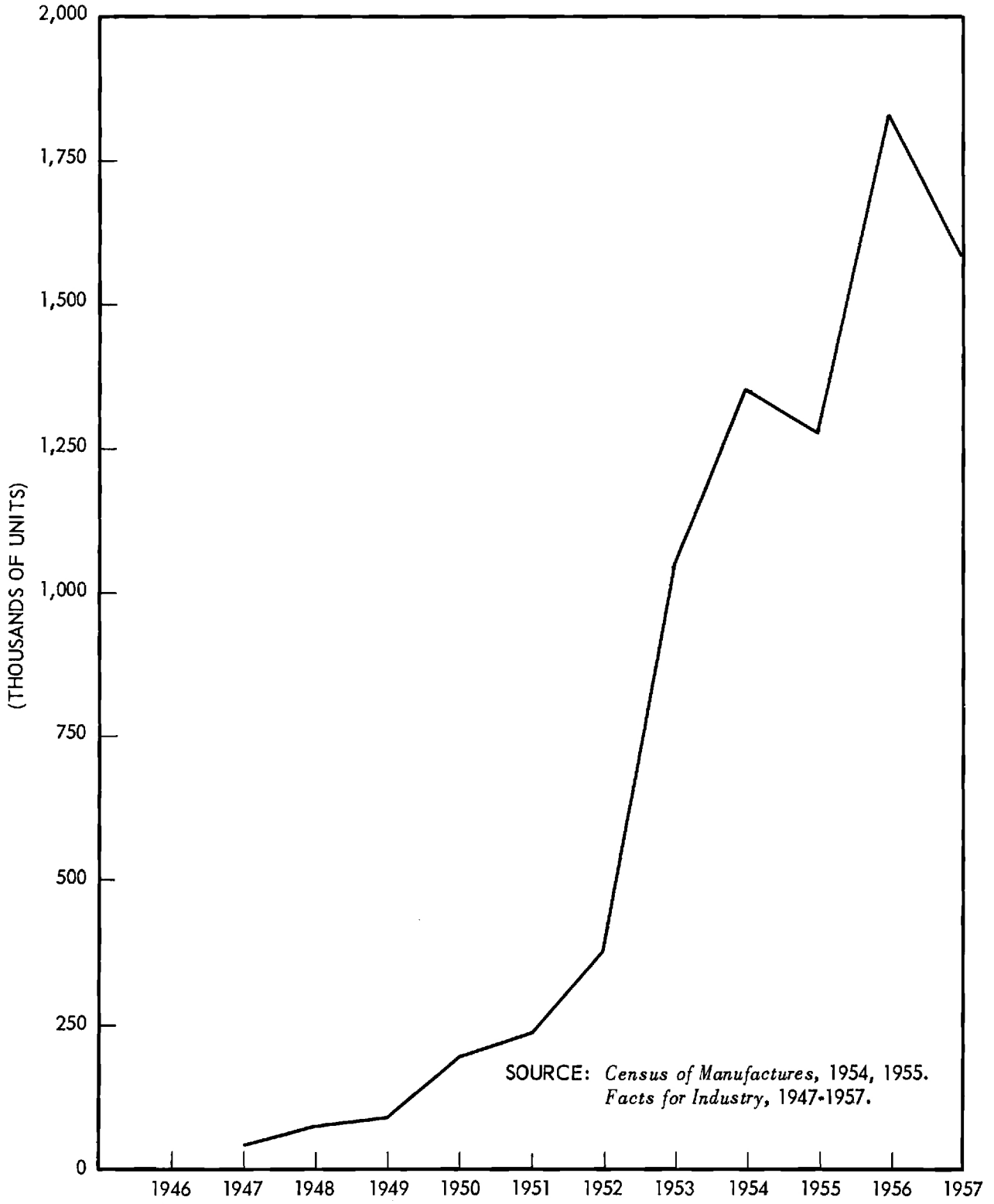


FIGURE 2
U.S. ROOM AIR CONDITIONER PRODUCTION, 1947-1957
(Two Year Moving Average)

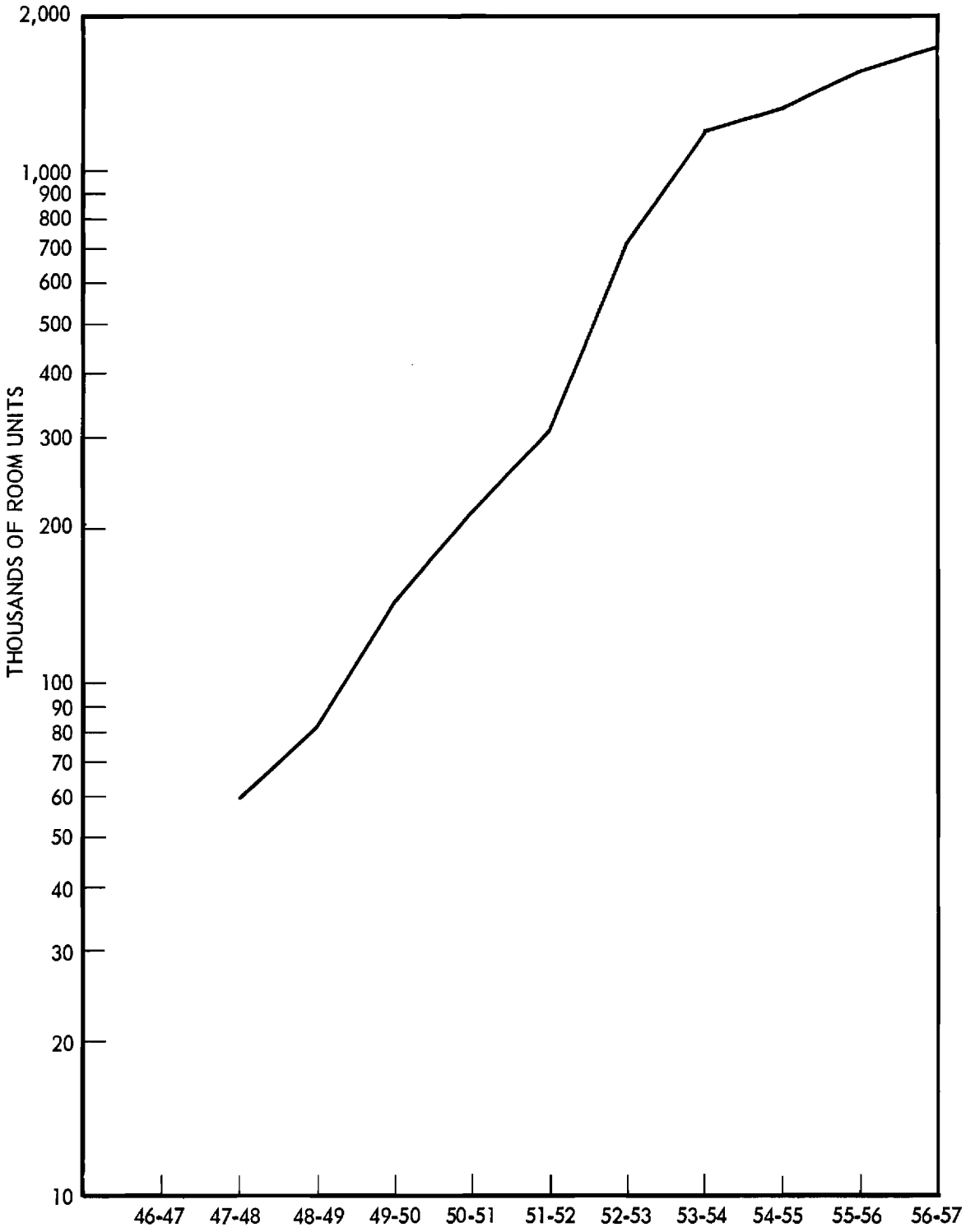
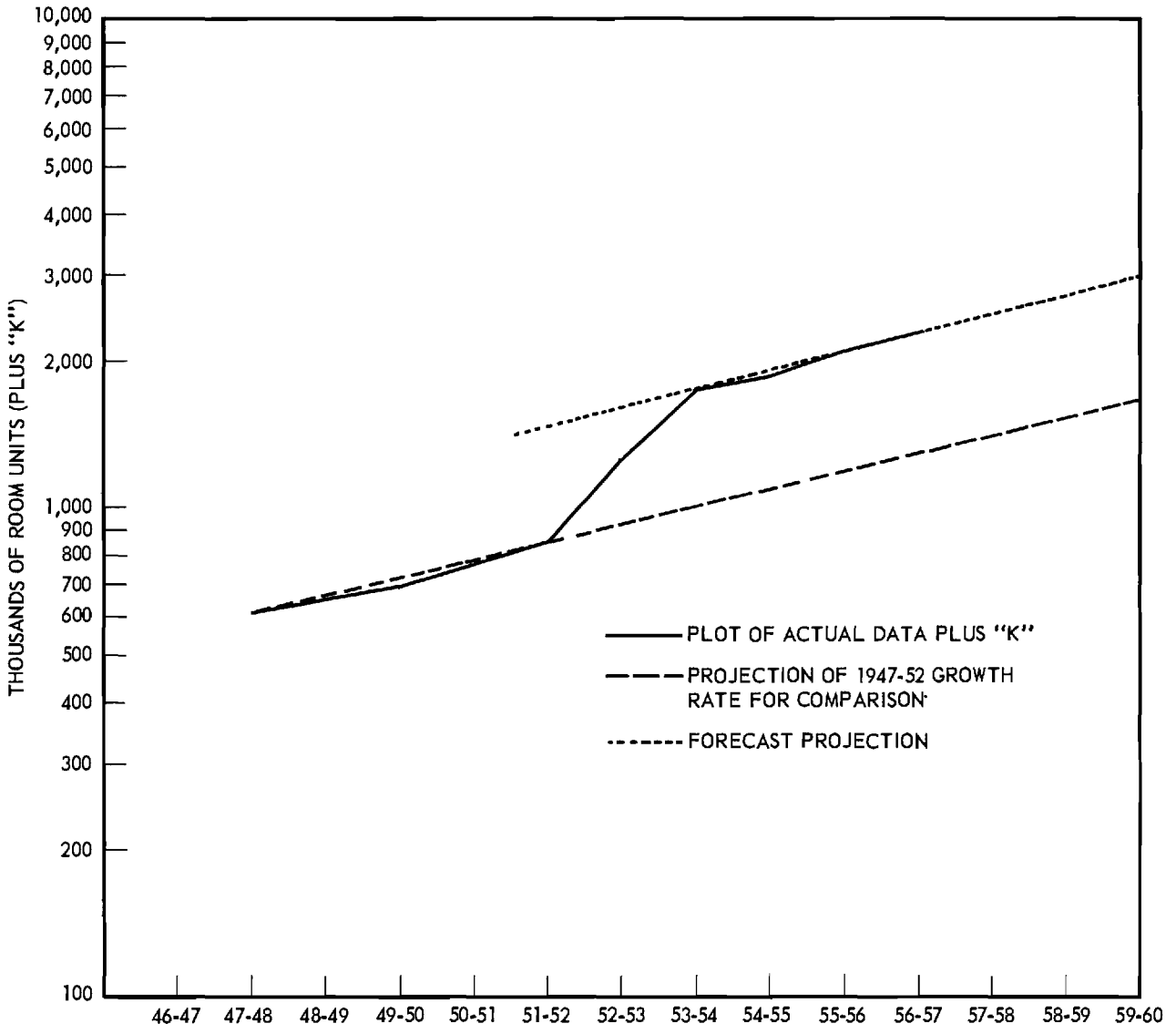


FIGURE 3
MODIFIED GROWTH CURVE*
(Two Year Moving Average)



*K = 547, See Appendix 2.

IV. THE COMPARATIVE LOCATION STUDY

The cost of shipping an assembled room air conditioner includes freight on sheet metal and hardware of the kind available almost everywhere. In addition, the unit's bulk includes empty space which, although necessary in air flow design, is costly to transport. As a consequence, market orientation of manufacturing plants affords an opportunity to reduce distribution costs of the assembled unit.

Clearly, there must be an optimum plant location with respect to costs of distribution. The total cost of distribution for a product manufactured in a given location depends on the volume shipped to the various markets served. Thus this cost is a function of the distance from the manufacturing site to the various markets, weighted by the volume of units shipped to those markets. If the volume shipped to each distribution point were known, a manufacturing site could be chosen in such a manner as to minimize the cost of distribution.

Appendix I sets forth estimates of sales by states. If these estimates could be allocated to more specific locations, then comparisons could be made between the location advantages of various manufacturing sites with respect to market penetration (in terms of access).

Data of the kind and extent suitable for such comparisons are not available, but after certain simplifying assumptions, approximations may be obtained. State sales data as such are not useful for comparative purposes, as it would be difficult to select a single point within a state from which distances to manufacturing sites would be representative statistically of the whole state. An alternative is to select from each state major distribution centers, allocate state sales proportionally to these centers, and compare their distances from the various cities with plants. This is the method used here.

Selection of Distribution Centers

The problem becomes one of selecting the distribution centers and developing a suitable method of proportional allocation. In general, major distribution centers are also major population centers. From each state those metropolitan areas were selected which account for at least 50 per cent of the total metropolitan area population in that state. The 50 per cent level was chosen simply to reduce the number of cities that would be involved, and consequently reduce the amount of computation.

Forty-three cities[1/] were selected and, insofar as possible, distances from these major distribution centers to cities with room air conditioner plants were obtained. In some cases, present sites are in cities for which distance tables would be very difficult to construct, and nearby major cities were substituted. Highway mileages were used in this study primarily because a considerable portion of room unit output is transported by truck. A mileage table was constructed as shown in Table III. The column headings are cities with plants or cities near plants of some of the major manufacturers of room units, plus certain other cities used for comparative purposes. The cities heading the rows are the selected distribution centers. The column totals are the total mileage between plant sites, actual or hypothetical, and the major markets in each state. If sales were the same in each of the selected cities, the most favored site would obviously be the one with the smallest column total (Louisville, Kentucky). Since sales are not uniformly distributed, the matter is in doubt until the mileages in the body of the table are weighted by the volume of shipments to each destination. The "weights" are an approximation of sales in the various metropolitan areas. They are derived by application of ratios to the estimates of state sales as derived in Appendix I. The ratios are simply the percentages of the states' total metropolitan area wholesale sales accounted for by the individual metropolitan areas.

For example, the "weights" for the Miami and Tampa metropolitan areas were derived as follows:

	Estimated Unit Sales ("Weight")	Sales of Merchant Wholesalers (Thousands of Dollars)[1/]
Florida	52,600	$1,323,972
Miami	(22,550)	567,534
Tampa-St. Pete	(12,566)	316,265
Other metropolitan areas		440,173

Source: Census of Business, 1954, U.S. Department of Commerce

1/ The metropolitan areas of Baltimore, Maryland, Norfolk-Portsmouth and Richmond, Virginia, and the District of Columbia which should be included by the method of selection, were not used. Sufficient sample data for state sales estimates were not available.

For Miami, the estimate would be 567,534/1,323,972 x 52,600 or 22,550; Tampa, 316,265/1,323,972 x 52,600 or 12,566. These two estimates are then applied as "weights" to distances from Miami and Tampa to the cities heading the columns.

The entries in the distance table were multiplied by similarly derived weights to obtain Table IV and summed as before. In this case, the distribution of sales is such that the location most favored with respect to national market penetration (given the 1957 national sales distribution as estimated in Appendix I, Table I) is again Louisville, Kentucky. The rank of the first six of the cities examined, in ascending order of weighted distances, is as follows: Louisville, Kentucky; Indianapolis, Indiana; Birmingham, Alabama; Memphis, Tennessee; Cincinnati, Ohio; and Atlanta, Georgia.

The reliability of the method of allocating sales among selected metropolitan areas is supported to a considerable extent by the findings of the LIFE Study of Consumer Expenditures in 1956.[1/] According to this survey, metropolitan area residents accounted for 79 per cent of the total air conditioner market; non-metropolitan area residents accounted for 21 per cent. The South was the only exception to this national pattern. In that region, sales were about equally divided between the two groups. This indicates that coverage of the southern markets involves a greater number of distribution points than in other regions, and that some advantage could be obtained by locating near these points. A further inference is that the results obtained in the location analysis possibly do not place the national market center as far south as it actually is. If more southern distribution centers had been included in the computations, the relative positions of the hypothetical southern plant locations would tend to improve, since the majority of the additional markets lie south of those chosen for the computations, and therefore farther from the present actual plant sites.

The implication of a southward shifting market center for future manufacturing plant location decisions is clear. If competitive advantages can be obtained by locating near the market center, then relocation or branch plant expansion of existing production facilities now elsewhere will result in a larger share of a growing market.

For practical purposes, the knowledge that the market center is shifting southward is sufficient to enable most manufacturers to improve significantly

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1/ LIFE Study of Consumer Expenditures, TIME, Incorporated, 1957.

TABLE III. MILEAGES

Locations / Markets	Des Moines Iowa	Chicago Illinois	Indianapolis Indiana	Cincinnati Ohio	Milwaukee Wisconsin	New York New York	Lansing Michigan	Buffalo New York	Baltimore Maryland	Weights
Birmingham, Ala.	860	676	525	499	772	993	752	933	807	15,104
Little Rock, Ark.	587	661	566	639	739	1,311	828	1,075	1,097	13,231
Los Angeles, Cal.	1,805	2,108	2,095	2,294	2,149	2,875	2,400	2,642	2,726	27,843
Bridgeport and New Haven, Conn.	1,261	932	785	713	1,022	78	806	428	245	5,006
Hartford, Conn.	1,287	958	823	751	1,034	119	815	395	286	4,541
Miami, Fla.	1,573	1,396	1,222	1,157	1,475	1,346	1,440	1,498	1,155	22,550
Tampa, Fla.	1,370	1,185	1,019	961	1,272	1,197	1,228	1,349	1,006	12,566
Atlanta, Ga.	899	715	549	466	814	863	760	901	694	58,615
Chicago, Ill.	341	0	191	302	97	831	205	538	669	52,550
Indianapolis, Ind.	472	191	0	110	281	710	248	492	565	16,994
Cedar Rapids, Iowa	119	227	395	505	248	1,068	432	765	896	2,223
Des Moines, Iowa	0	341	472	582	364	1,165	558	871	1,019	8,376
Sioux City, Iowa	197	504	666	776	500	1,345	709	1,042	1,173	4,162
Kansas City, Kan.	206	504	484	599	572	1,223	694	981	1,065	23,921
Wichita, Kan.	422	722	712	826	790	1,441	932	1,208	1,303	13,361
Louisville, Ky.	585	311	118	109	399	771	344	547	617	10,677
New Orleans, La.	1,056	977	845	843	1,067	1,361	1,090	1,275	1,173	62,249
Boston, Mass.	1,313	992	936	864	1,138	222	800	460	387	7,939
Detroit, Mich.	607	279	273	256	369	645	84	255	519	6,143
Minn.-St. Paul, Minn.	264	420	611	713	351	1,261	628	956	1,107	15,451
Jackson, Miss.	844	760	667	703	840	1,248	929	1,159	1,060	10,600
St. Louis, Mo.	368	291	238	346	388	969	485	732	816	24,208
Omaha, Neb.	140	486	592	700	502	1,295	698	1,011	1,148	11,681
New York, N. Y.	1,165	831	710	647	931	0	711	373	184	140,395
Charlotte, N. C.	1,049	775	583	492	865	618	737	761	433	12,344
Greensboro-High Point and Winston-Salem, N. C.	1,071	797	640	542	894	529	724	656	342	8,217

TABLE III. MILEAGES (Continued)

Locations / Markets	Des Moines Iowa	Chicago Illinois	Indianapolis Indiana	Cincinnati Ohio	Milwaukee Wisconsin	New York New York	Lansing Michigan	Buffalo New York	Baltimore Maryland	Weights
Cincinnati, Ohio	582	302	110	0	392	647	277	436	500	8,058
Cleveland, Ohio	678	335	306	242	439	488	223	192	333	14,924
Columbus, Ohio	645	313	173	108	402	537	236	332	392	5,396
Oklahoma City, Okla.	563	850	797	895	914	1,526	1,038	1,284	1,368	13,396
Philadelphia, Pa.	1,083	773	652	577	863	88	634	364	102	34,916
Pittsburg, Pa.	789	461	356	284	550	364	341	222	209	15,440
Columbia, S. C.	1,111	828	622	536	894	703	837	862	517	27,266
Greenville, S. C.	1,027	730	538	440	827	718	717	861	533	15,216
Knoxville, Tenn.	868	573	385	281	666	726	558	844	541	6,401
Memphis, Tenn.	637	562	453	500	652	1,170	699	933	958	46,663
Dallas, Texas	709	955	920	981	1,054	1,632	1,163	1,409	1,441	50,968
Houston, Texas	954	1,102	1,041	1,090	1,180	1,709	1,299	1,525	1,484	58,006
San Antonio, Texas	987	1,242	1,185	1,248	1,324	1,889	1,435	1,660	1,684	15,549
Milwaukee, Wisc.	364	97	281	392	0	931	297	626	759	11,615
Totals	30,858	27,162	24,536	24,969	30,030	38,612	29,791	34,853	33,313	

TABLE III. MILEAGES

Locations / Markets	Atlanta Georgia	Birmingham Alabama	Charlotte North Carolina	Dallas Texas	Jackson Mississippi	Louisville Kentucky	Memphis Tennessee	New Orleans Louisiana	Weights
Birmingham, Ala.	158	0	418	672	254	399	255	365	15,104
Little Rock, Ark.	562	395	780	340	269	552	139	461	13,231
Los Angeles, Cal.	2,289	2,122	2,460	1,429	1,869	2,127	1,824	1,937	27,843
Bridgeport and New Haven, Conn.	932	1,049	685	1,701	1,303	820	1,203	1,426	5,006
Hartford, Conn.	992	1,107	732	1,736	1,355	860	1,255	1,472	4,541
Miami, Fla.	672	783	751	1,374	952	1,116	1,042	887	22,550
Tampa, Fla.	461	546	593	1,120	684	911	813	650	12,566
Atlanta, Ga.	0	158	260	839	421	432	423	513	58,615
Chicago, Ill.	715	676	775	955	760	311	562	977	52,550
Indianapolis, Ind.	549	525	583	920	667	118	453	845	16,994
Cedar Rapids, Iowa	861	823	977	828	830	513	621	1,025	2,223
Des Moines, Iowa	899	860	1,049	709	844	585	637	1,056	8,376
Sioux City, Iowa	1,106	1,028	1,246	777	986	784	773	1,179	4,162
Kansas City, Kan.	805	726	984	498	681	526	468	878	23,921
Wichita, Kan.	1,038	849	1,153	391	756	744	561	842	13,361
Louisville, Ky.	432	399	464	879	593	0	383	737	10,677
New Orleans, La.	513	365	783	498	195	737	410	0	62,249
Boston, Mass.	1,084	1,220	845	1,868	1,470	973	1,389	1,583	7,939
Detroit, Mich.	741	755	689	1,194	942	363	751	1,099	6,143
Minn.-St. Paul, Minn.	1,097	1,058	1,193	960	1,084	729	864	1,279	15,451
Jackson, Miss.	421	254	681	418	0	593	213	195	10,600
St. Louis, Mo.	550	511	720	657	518	267	303	724	24,208
Omaha, Neb.	1,014	937	1,174	682	890	710	680	1,086	11,681
New York, N. Y.	863	993	618	1,649	1,248	771	1,170	1,361	140,395
Charlotte, N. C.	260	418	0	1,099	681	464	636	783	12,344
Greensboro-High Point and Winston-Salem, N. C.	337	498	78	1,170	757	486	735	850	8,217

TABLE III. MILEAGES (Continued)

Locations / Markets	Atlanta Georgia	Birmingham Alabama	Charlotte North Carolina	Dallas Texas	Jackson Mississippi	Louisville Kentucky	Memphis Tennessee	New Orleans Louisiana	Weights
Cincinnati, Ohio	466	499	492	981	703	109	500	843	8,058
Cleveland, Ohio	709	741	574	1,218	953	351	741	1,084	14,924
Columbus, Ohio	560	593	501	1,092	813	221	610	943	5,396
Oklahoma City, Okla.	912	745	1,126	214	602	814	487	683	13,396
Philadelphia, Pa.	776	893	528	1,561	1,163	689	1,076	1,276	34,916
Pittsburg, Pa.	741	812	535	1,282	977	404	803	1,116	15,440
Columbia, S. C.	219	383	95	1,065	646	518	654	742	27,266
Greenville, S. C.	159	317	101	989	571	419	541	672	15,216
Knoxville, Tenn.	201	267	226	896	521	267	415	632	6,401
Memphis, Tenn.	423	255	636	470	213	383	0	410	46,663
Dallas, Texas	839	672	1,099	0	418	879	470	498	50,968
Houston, Texas	842	677	1,101	242	422	987	580	391	58,006
San Antonio, Texas	1,022	864	1,288	278	610	1,137	726	585	15,549
Milwaukee, Wisc.	814	772	865	1,054	840	399	652	1,067	11,615
Totals	28,034	27,545	29,858	36,705	30,461	24,468	26,818	35,612	

TABLE IV. WEIGHTED MILEAGES

Markets \ Locations	Des Moines Iowa	Chicago Illinois	Indianapolis Indiana	Cincinnati Ohio	Milwaukee Wisconsin	New York New York	Lansing Michigan	Buffalo New York	Baltimore Maryland
Birmingham, Ala.	12,989	10,210	7,930	7,537	11,660	14,998	11,358	14,092	12,189
Little Rock, Ark.	7,767	8,746	7,489	8,455	9,785	17,346	10,955	14,223	14,514
Los Angeles, Cal.	50,257	58,698	58,331	63,872	59,835	80,049	66,823	73,561	75,900
Bridgeport and New Haven, Conn.	6,313	4,666	3,930	3,569	5,116	390	4,035	2,143	1,226
Hartford, Conn.	5,844	4,350	3,737	3,410	4,695	540	3,701	1,794	1,299
Miami, Fla.	35,471	31,480	27,556	26,090	33,261	30,352	32,472	33,780	26,045
Tampa, Fla.	17,215	14,891	12,805	12,076	15,984	15,042	15,431	16,952	12,641
Atlanta, Ga.	52,695	41,910	32,180	27,315	47,713	50,585	44,547	52,812	40,679
Chicago, Ill.	17,920	0	10,037	15,870	5,097	43,669	10,773	28,272	35,156
Indianapolis, Ind.	8,021	3,246	0	1,869	4,775	12,066	4,215	8,361	9,602
Cedar Rapids, Iowa	265	505	878	1,123	551	2,374	960	1,701	1,992
Des Moines, Iowa	0	2,856	3,953	4,875	3,049	9,758	4,674	7,295	8,535
Sioux City, Iowa	820	2,098	2,772	3,230	2,081	5,598	2,951	4,337	4,882
Kansas City, Kan.	4,928	12,056	11,578	14,329	13,683	29,255	16,601	23,467	25,476
Wichita, Kan.	5,638	9,647	9,513	11,036	10,555	19,253	12,452	16,140	17,409
Louisville, Ky.	6,246	3,321	1,260	1,164	4,260	8,232	3,673	5,840	6,588
New Orleans, La.	65,735	60,817	52,600	52,476	66,420	84,721	67,851	79,367	73,018
Boston, Mass.	10,424	7,875	7,431	6,859	9,035	1,762	6,351	3,652	3,072
Detroit, Mich.	3,729	1,714	1,677	1,573	2,267	3,962	516	1,566	3,188
Minn.-St. Paul, Minn.	4,079	6,489	9,441	11,017	5,423	19,484	9,703	14,771	17,104
Jackson, Miss.	8,946	8,056	7,070	7,451	8,904	13,229	9,847	12,285	11,236
St. Louis, Mo.	8,909	7,045	5,762	8,376	9,393	23,458	11,741	17,720	19,754
Omaha, Neb.	1,635	5,677	6,915	8,177	5,864	15,127	8,153	11,809	13,410
New York, N. Y.	163,560	116,668	99,680	90,836	130,708	0	99,821	52,367	25,833
Charlotte, N. C.	12,949	9,567	7,197	6,073	10,678	7,629	9,098	9,394	5,345
Greensboro-High Point and Winston-Salem, N. C.	8,800	6,549	5,259	4,454	7,346	4,347	5,949	5,390	2,810

TABLE IV. WEIGHTED MILEAGES (Continued)

Markets \ Locations	Des Moines Iowa	Chicago Illinois	Indianapolis Indiana	Cincinnati Ohio	Milwaukee Wisconsin	New York New York	Lansing Michigan	Buffalo New York	Baltimore Maryland
Cincinnati, Ohio	4,690	2,434	886	0	3,159	5,214	2,232	3,513	4,029
Cleveland, Ohio	10,118	5,000	4,567	3,612	6,552	7,283	3,328	2,865	4,970
Columbus, Ohio	3,480	1,689	934	583	2,169	2,898	1,273	1,791	2,115
Oklahoma City, Okla.	7,542	11,387	10,677	11,989	12,244	20,442	13,905	17,200	18,326
Philadelphia, Pa.	37,814	26,990	22,765	20,147	30,133	3,073	22,137	12,709	3,561
Pittsburg, Pa.	12,182	7,118	5,497	4,385	8,492	5,620	5,265	3,428	3,227
Columbia, S. C.	30,293	22,576	16,959	14,615	24,376	19,168	22,822	23,503	14,097
Greenville, S. C.	15,627	11,108	8,186	6,695	12,583	10,925	10,910	13,101	8,110
Knoxville, Tenn.	5,556	3,668	2,464	1,799	4,263	4,647	3,572	5,402	3,463
Memphis, Tenn.	29,724	26,225	21,138	23,332	30,424	54,596	32,617	43,537	44,703
Dallas, Texas	36,136	48,674	46,891	50,000	53,720	83,180	59,276	71,814	73,445
Houston, Texas	55,338	63,923	60,384	63,227	68,447	99,132	75,350	88,459	86,081
San Antonio, Texas	15,347	19,312	18,426	19,405	20,587	29,372	22,313	25,811	26,185
Milwaukee, Wisc.	4,228	1,127	3,264	4,553	0	10,814	3,450	7,271	8,816
Totals	789,230	690,368	620,019	627,454	765,287	869,590	753,101	833,495	770,031

TABLE IV. WEIGHTED MILEAGES

Locations / Markets	Atlanta Georgia	Birmingham Alabama	Charlotte North Carolina	Dallas Texas	Jackson Mississippi	Louisville Kentucky	Memphis Tennessee	New Orleans Louisiana
Birmingham, Ala.	2,386	0	6,313	10,150	3,836	6,026	3,852	5,513
Little Rock, Ark.	7,436	5,226	10,320	4,499	3,559	7,304	1,832	6,099
Los Angeles, Cal.	63,733	59,080	68,494	39,786	52,039	59,222	50,786	53,932
Bridgeport and New Haven, Conn.	4,666	5,251	3,429	8,515	6,523	4,105	6,022	7,139
Hartford, Conn.	4,505	5,027	3,324	7,883	6,153	3,905	5,699	6,684
Miami, Fla.	15,154	17,657	16,935	30,984	21,468	25,166	23,497	20,002
Tampa, Fla.	5,793	6,861	7,452	14,074	8,595	11,448	10,216	8,168
Atlanta, Ga.	0	9,261	15,240	49,178	24,677	25,322	24,794	30,069
Chicago, Ill.	37,573	35,524	40,726	50,185	39,938	16,343	29,533	51,341
Indianapolis, Ind.	9,330	8,922	9,908	15,634	11,335	2,005	7,698	14,360
Cedar Rapids, Iowa	1,914	1,830	2,172	1,841	1,845	1,140	1,380	2,279
Des Moines, Iowa	7,530	7,203	8,786	5,939	7,069	4,900	5,336	8,845
Sioux City, Iowa	4,603	4,279	5,186	3,234	4,104	3,263	3,217	4,907
Kansas City, Kan.	19,256	17,367	23,538	11,913	16,290	12,582	11,195	21,003
Wichita, Kan.	13,869	11,343	15,405	5,224	10,101	9,941	7,496	11,250
Louisville, Ky.	4,612	4,260	4,954	9,385	6,331	0	4,089	7,869
New Orleans, La.	31,934	22,720	48,741	31,000	12,139	45,878	25,522	0
Boston, Mass.	8,606	9,686	6,708	14,830	11,670	7,725	11,027	12,567
Detroit, Mich.	4,552	4,638	4,233	7,335	5,787	2,230	4,613	6,751
Minn.-St. Paul, Minn.	16,950	16,347	18,433	14,833	16,749	11,264	13,350	19,762
Jackson, Miss.	4,463	2,692	7,219	4,431	0	6,286	2,258	2,067
St. Louis, Mo.	13,314	12,370	17,430	15,905	12,540	6,464	7,335	17,527
Omaha, Neb.	11,845	10,945	13,713	7,966	10,396	8,294	7,943	12,686
New York, N. Y.	121,161	139,412	86,764	231,511	175,213	108,245	164,262	191,078
Charlotte, N. C.	3,209	5,160	0	13,566	8,406	5,728	7,851	9,665
Greensboro-High Point and Winston-Salem, N. C.	2,769	4,092	641	9,614	6,220	3,993	6,039	6,984

TABLE IV. WEIGHTED MILEAGES (Continued)

Locations / Markets	Atlanta Georgia	Birmingham Alabama	Charlotte North Carolina	Dallas Texas	Jackson Mississippi	Louisville Kentucky	Memphis Tennessee	New Orleans Louisiana
Cincinnati, Ohio	3,755	4,021	3,965	7,905	5,665	878	4,029	6,793
Cleveland, Ohio	10,581	11,059	8,566	18,177	14,223	5,238	11,059	16,178
Columbus, Ohio	3,022	3,200	2,703	5,892	4,387	1,193	3,292	5,088
Oklahoma City, Okla.	12,217	9,980	15,084	2,867	8,064	10,904	6,524	9,149
Philadelphia, Pa.	27,095	31,180	18,436	54,504	40,607	24,057	37,570	44,553
Pittsburg, Pa.	11,441	12,537	8,260	19,794	15,085	6,238	12,398	17,231
Columbia, S. C.	5,971	10,443	2,590	29,038	17,614	14,124	17,832	20,231
Greenville, S. C.	2,419	4,823	1,537	15,049	8,688	6,376	8,232	10,225
Knoxville, Tenn.	1,287	1,709	1,447	5,735	3,335	1,709	2,656	4,045
Memphis, Tenn.	19,738	11,899	29,678	21,932	9,939	17,872	0	19,132
Dallas, Texas	42,762	34,250	56,014	0	21,305	44,801	23,955	25,382
Houston, Texas	48,841	39,270	63,865	14,037	24,479	57,252	33,643	22,680
San Antonio, Texas	15,891	13,434	20,027	4,323	9,485	17,680	11,288	9,096
Milwaukee, Wisc.	9,455	8,967	10,047	12,242	9,757	4,634	7,573	12,393
Totals	635,638	623,925	688,283	830,910	675,616	611,735	626,893	760,723

their competitive positions in either the national or the southern regional market. In the process they would gain any advantages to be offered by newer production equipment and layout resulting from relocation or expansion of production facilities.

The structure of freight rates, which often involves zones of equal cost, makes it unnecessary to locate in a mathematically determined position to obtain the desired transportation advantages. From the more practical point of view, it is sufficient to choose a location near the market center which has other desirable location advantages, such as good transportation facilities and a plentiful labor supply with the necessary skills or trainability.

A manufacturer who wishes to concentrate primarily on regional sales, should choose a southern location for much the same reasons. A well chosen southern location would obtain regional market advantages, and would be near the area toward which the national market center is moving. Such a location would enable a producer to improve national penetration over time.

Regional specialization is not feasible unless the regional market in question is sufficient to absorb a major part of the manufacturer's output, and has enough growth potential to support planned increases in output. Of the two regions which meet the first requisite, the South is undoubtedly in a more favored position, as it has the greater growth potential. If regional specialization is at all desirable, there is little doubt of the choice between regions.

The remainder of this study is a consideration of the vicinity of Atlanta, Georgia, as a manufacturing location for the room air conditioner industry.

V. ATLANTA AS A LOCATION FOR THE ROOM AIR CONDITIONER INDUSTRY

Of the first six cities in rank of nearness to the national market center,[1/] only three lie south of Louisville: Birmingham, Memphis, and Atlanta. These are the cities which will improve their positions as the market center shifts southward. Of these three, Atlanta has the advantage of being approximately equidistant from the East Texas-Gulf Coast markets and the Middle Atlantic-Eastern Seaboard markets, a fact of some importance in terms of transport time. Also, Atlanta has better developed transport-distribution facilities. Of course, a realistic plant location decision would have to be based on additional factors, such as desirable site availability and a study of the actual dollar costs of distribution for each of the three cities. As a preliminary step in that direction, certain general factors will be given attention in this report.

The Labor Market

Among the many factors to be considered in a location decision, the supply of suitable labor is perhaps one of the most important. The Atlanta labor supply is favorable for industry.

The standard definition of the Atlanta labor market area includes Fulton, DeKalb, Cobb and Clayton[2/] counties, although employers in the area actually draw on a much larger labor market area. The population in these four counties has increased nearly one-third since the 1950 Census. The trends by county are shown in Table V.

TABLE V

GROWTH OF METROPOLITAN ATLANTA POPULATION
1950-1958

County	Population 1950	Population 1958	Per Cent Increase
Fulton	473,572	564,500	19.2
DeKalb	136,395	222,000	62.8
Cobb	61,830	95,500	54.5
Clayton	22,872	33,000	44.3
Totals	694,669	915,000	31.7

1/ See page 19.

2/ After this study was completed Gwinnett County was added to the Atlanta labor market area.

Some of this increase may be attributed to the employment opportunities in the transportation industry in these counties, but more fundamental is the general economic evolution from agriculture to industry, improved agricultural technology, and a tendency for displaced farm labor to migrate to urban areas with better job opportunities.

Commuting is also an important factor in the labor supply. A recent study of commuting[1/] shows that 29 per cent of employees in the four-county area do not reside in the county in which they work. Further, 15 per cent of Metropolitan Atlanta workers do not reside within the four-county area. It is also noted that:

> The effect of prestige firms with high wage scales on the relative number of workers from outside counties can be determined from statistics on the aircraft and automobile assembly operations, involving several different establishments in the Greater Atlanta area. The data indicate that these plants obtained 54 per cent of their workers from counties other than the county where the plant is located.[2/]

Labor Costs

Much has been said and written about the higher productivity of southern workers. This subject received national attention in 1954 in an article by Robock and Peterson in the Harvard Business Review.[3/] As pointed out in this article, the preponderance of case studies indicates lower labor costs, not merely lower wage rates, than in other parts of the country. This is accounted for by the large reserve of labor that new industry can draw upon, which enables an employer to be extremely selective in hiring applicants.

It is doubtful that wage differentials which may now exist can be expected to endure indefinitely. However, as the differentials decrease, the more attractive wage rates will cause more workers to enter the market for industrial labor, maintaining the advantages of selectivity.

Technical Training

Many manufacturers moving into a new location bring a cadre of trained personnel to act in a supervisory role, particularly during the training

1/ "Analysis of Intercounty Commuting of Workers in Georgia," John L. Fulmer, Industrial Development Branch, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia, August 1958.

2/ Ibid., p. 12

3/ "Fact and Fiction About Southern Labor," Stefan H. Robock and John M. Peterson, Harvard Business Review, March-April 1954.

period. For some types of operations, employers prefer to provide all of the training required, selecting applicants on the basis of aptitude rather than acquired skills or special technical knowledge. This may be especially desirable on assembly line operations, such as are found in room air conditioner plants. Much of the available labor in the Atlanta labor market will be of the unskilled, untrained type.

There will be an eventual, if not initial, need for some persons possessing skill and training in refrigeration mechanics. This need can also be met in the Atlanta labor market. The Southern Technical Institute, a unit of the Georgia Institute of Technology, is located in Chamblee, Georgia, approximately 13 miles northeast of Atlanta. "Southern Tech" offers an accredited Associate in Science degree in 11 technical fields, including heating and air conditioning. The number of graduates in heating and air conditioning technology is indicated in the following tabulation:

Year	Graduates
1954	17
1955	22
1956	32
1957	34
1958	27

Another advantage of an Atlanta location, in terms of educational facilities, is found in the proximity of the Georgia Institute of Technology and Emory University in Atlanta, and the University of Georgia in Athens. Georgia Tech is the site of the largest engineering research facility in the South.

Proximity to Markets

Atlanta's proximity to the center of the room air conditioner market has already been developed in terms of geographical location. The advantage that would be obtained by locating near Atlanta is further enhanced by the ease of accessibility to the entire market area.

Long the distribution center for the South, Atlanta has well developed transportation facilities for shipment to any part of the region or nation. There are 13 main lines of 7 railway systems radiating from Atlanta. More than 250 merchandise and package cars originate in and move out from the city daily, in addition to regular car lots. Through express car service is operated between Atlanta and Boston, New York, Chicago, Cincinnati, St. Louis,

Los Angeles, Jacksonville, Miami, New Orleans, and other cities.

At the time of this writing there are 65 regularly scheduled, interstate, general commodity truck lines serving Atlanta, along with approximately 30 contract carriers.

It is worthy of note that Atlanta will be a point of intersection for three of the interstate highways. Thus six super-highways will radiate from Atlanta to all sections of the nation; and doubtless will increase the city's advantages as a transportation-distribution center.

Appendix I

ESTIMATES OF SALES

The sales estimates are based on sample sales data published in Electrical Merchandising[1/] and Electric Light and Power.[2/] Basically, the data consists of reports from electric utilities which estimated the number of unit sales of room air conditioners for 1957 and the number of domestic customers on residential rates in their territories. In the case of Electrical Merchandising, some 246 utilities, serving approximately 85 per cent of the nation's domestic customers, cooperated in the survey. One hundred and fifty-four utilities, serving approximately 80 per cent of the nation's domestic customers, contributed to the survey reported in Electric Light and Power. This later survey duplicated extensively the coverage of the first survey, and was used to amend the earlier estimates of sales and number of customers wherever possible.

The total number of customers in each state was obtained from the Statistical Bulletin, Electric Utility Industry in the United States, published by the Edison Electric Institute. Since these data are reported as of the end of the year, the 1956 and 1957 data were averaged to obtain a result more representative of the sales period.

From these data, unit sales and number of domestic customers, the rate of buying for the year 1957 could be determined for the sample, on the state level. The method used to estimate total sales for each state was to assume that the rate of buying in the sample is applicable for the total number of customers in each state. The estimates are displayed in Appendix I.

As a check on the result for the nation's total sales, estimates of beginning and ending inventories and actual production were used. According to Electrical Merchandising, inventories at the end of 1956 and 1957 were approximately 450,000 and 750,000 units, respectively. Production in 1957 as reported by the U.S. Department of Commerce[3/] was 1,586,094 units. If the inventory figures are assumed correct to the nearer 50,000 units, then the allowable range

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1/ Statistical and Marketing Issue, McGraw-Hill Publishing Company, New York, January, 1958.

2/ Twenty-Eighth Annual Major Appliance Survey," Haywood Publishing Company of Delaware, Chicago, Illinois, July 15, 1958, p. 66 ff.

3/ Facts for Industry series

for total estimated sales is from 1,236,000 to 1,336,000 units.[1/] The total state sales imputed from the sample, as described previously, are 1,240,500 units, well within the allowable range, considering that this total does not include estimates for Maryland, Virginia, and the District of Columbia.

Since the sample data are not random, there is no precise measure of the accuracy of individual state estimates. Obviously, the larger the sample for a state the better the estimate of the state total. Some indication of relative accuracy among the states is found in the per cent of the total customers included in the sample for each state as indicated in Appendix Table II.

1/ Derived as follows:

Beginning inventory	425,000 to 475,000 units
Add production	1,586,000 units
Total available stock	2,011,000 to 2,061,000 units
Less ending inventory	725,000 to 775,000 units
Total sales	1,236,000 to 1,336,000 units

Appendix Table I

ESTIMATED SALES OF ROOM AIR CONDITIONERS
BY STATE, 1957

Region or State	No. of Units
New England	28,700
Maine	900
New Hampshire	1,500
Vermont	100
Massachusetts	11,000
Rhode Island	600
Connecticut	14,600
Middle Atlantic	222,000
New York	130,300
New Jersey	27,900
Pennsylvania	63,800
East North Central	151,900
Ohio	41,700
Indiana	31,600
Illinois	54,400
Michigan	8,500
Wisconsin	15,700
West North Central	123,100
Minnesota	17,400
Iowa	20,300
Missouri	42,400
North Dakota	4,100
South Dakota	1,500
Nebraska	12,300
Kansas	25,300
South Atlantic	208,000 1/
Delaware	1,800
Maryland	--
Washington, D. C.	--
South Atlantic (Contd.)	
Virginia	--
West Virginia	2,200
North Carolina	28,700
South Carolina	43,800
Georgia	78,900
Florida	52,600
East South Central	122,800
Kentucky	13,100
Tennessee	72,900
Alabama	26,200
Mississippi	10,600
West South Central	309,600
Arkansas	17,000
Louisiana	81,000
Oklahoma	22,900
Texas	188,700
Mountain	17,000
Montana	500
Idaho	1,700
Wyoming	1,000
Colorado	2,000
New Mexico	2,800
Arizona	6,300
Utah	1,000
Nevada	1,700
Pacific	57,400
Washington	2,800
Oregon	2,800
California	51,800
Total	1,240,500

1/ Regional total does not include estimates for Maryland, Virginia, and Washington, D. C.

Appendix Table II

PER CENT OF TOTAL RESIDENTIAL UTILITY CUSTOMERS INCLUDED IN THE SAMPLE

Region or State	Per Cent
New England	71.4
Maine	14.4
New Hampshire	72.1
Vermont	50.8
Massachusetts	86.6
Rhode Island	86.0
Connecticut	90.3
Middle Atlantic	77.0
New York	84.3
New Jersey	27.2
Pennsylvania	93.6
East North Central	65.8
Ohio	66.4
Indiana	19.2
Illinois	74.2
Michigan	84.3
Wisconsin	60.8
West North Central	44.9
Minnesota	63.3
Iowa	30.5
Missouri	53.4
North Dakota	4.9
South Dakota	30.0
Nebraska	49.1
Kansas	30.8
South Atlantic	58.1 1/
Delaware	64.4
Maryland	--
Washington, D. C.	--
Virginia	--
West Virginia	46.8
South Atlantic	--
North Carolina	87.3
South Carolina	27.4
Georgia	55.8
Florida	30.0
East South Central	48.8
Kentucky	36.9
Tennessee	41.6
Alabama	72.8
Mississippi	45.4
West South Central	67.3
Arkansas	65.3
Louisiana	63.7
Oklahoma	76.2
Texas	66.3
Mountain	59.2
Montana	72.5
Idaho	60.0
Wyoming	14.5
Colorado	70.5
New Mexico	4.3
Arizona	68.1
Utah	88.5
Nevada	33.1
Pacific	79.7
Washington	16.1
Oregon	48.3
California	95.9
Total U.S.	65.7 1/

1/ Totals do not include data for Maryland, Virginia, and Washington, D. C.

Appendix II

FORECAST METHODOLOGY

An arithmetic graph of production data from 1947 to 1957 reveals quite clearly that after the tremendous expansion of output from 1952 to 1954, the industry was faced with an inventory problem. The recessions of 1954 and late 1957 contributed to this problem and incidentally lend an element of conservatism to the forecasts.

To overcome the effects of inventory adjustments, two-year moving averages of the production data were used as the basis of the forecasts. This adjustment of the data also has a tendency to bring production more in line with actual sales, so that although technically production is being forecast, the results should be reasonably close to sales.

The Modified Exponential Method

After the adjustment, the data still show no obvious tendency to regularity of growth (Figure 2). It will be noted that the logarithmic graph passes through three cycles of these orders of magnitude: 10^1, 10^2, and 10^3. This characteristic can obscure regularity in growth simply through differences in magnitude of the data. A transformation was applied to reveal any such hidden tendency.

To each production datum, a constant factor (K) of 547[1/] was added. This transformation has the effect of giving more emphasis to the increases from year to year. The transformed data is graphed in Figure 3.

By a linear extrapolation of the last section of the curve in Figure 3, and subtracting K, the first forecast of 2,250,000 units in 1959-60 was obtained. For short term forecasts this method, termed "fitting a modified exponential curve," may be quite satisfactory.

1/ Derived by grouping the data into three parts: 1947-48, 1948-49, 1949-50, 1950-51; 1950-51, 1951-52, 1952-53, 1953-54; 1953-54, 1954-55, 1955-56, 1956-57. Summing and averaging, the mean of part 1 (designated as M_1) is 124.75, M_2 = 609.25, M_3 = 1,443.00. Then,

$$K = \left[M_2^2 - (M_1 M_3)\right] \div \left[(M_1 + M_3) - 2M_2\right] = 547.$$

The K is added algebraically, i.e., a negative K would be subtracted.

Correlation Method

As a check on the results of the first method, U.S. total production and personal income were tested for degree of correlation for the purpose of using an income forecast as a basis for a production forecast. The advantage of such a method is that the wide range of factors determining income provides a much more stable base, and consequently greater reliability, than assumptions that might be made for the future of a particular product.

Two adjustments were made in the income data. The data were deflated to reflect price level changes, and converted to a two-year moving average series to increase the time-comparability of the two sets of data.

By least squares regression the following equations were specified, with the indicated correlation coefficients:

$$P = -4,313 + 21.22158(Y) \qquad (r = 0.96)$$

$$Y = 193.85 + 9.7212(T) \qquad (r = 0.99)$$

where P = Production, Y = Income, T = Time, origin at 1947-48.

The forecast obtained for 1959-60 is 2,280,000 units, which closely agrees with the former forecast of 2,250,000 units.